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(54) Abstract Title: **DISPLAY DEVICE HAVING DIVERGING DISPLAY SURFACES**

(57) A display device comprises two surfaces 14, 16 facing one another and diverging from one another, wherein optically distorted images 20, 22 are displayed on the surfaces 14, 16. When the line or projected line of convergence of the surfaces 14, 16 is substantially perpendicular to a viewing plane containing the user's eyes, the user sees the illusion of a single image on looking between the two surfaces 14, 16 in a direction such that they converge away from the user's eyes. A red dot 40 may be printed in the centre of the upper strip 30 on which the user's eye should focus on. The surfaces 14, 16 may be in the form of liquid crystal displays (LCD) and form a three-dimensional (3D) image. The display device may also be capable of being folded flat. The optically distorted images 20, 22 may be generated from a stereo pair of undistorted images. The display device may also be cinema sized, and is viewed using a blinkering device which only allows the presentation of one of the distorted images to each of the user's eyes.

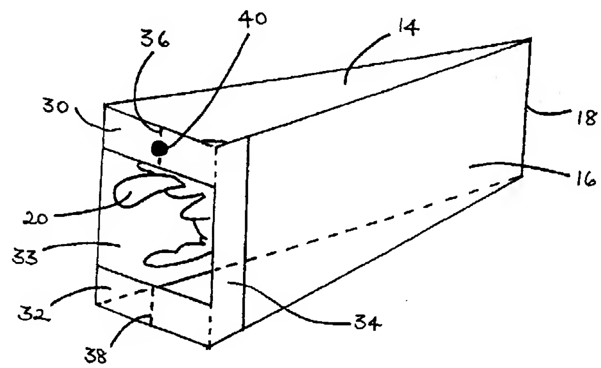

FIGURE 1

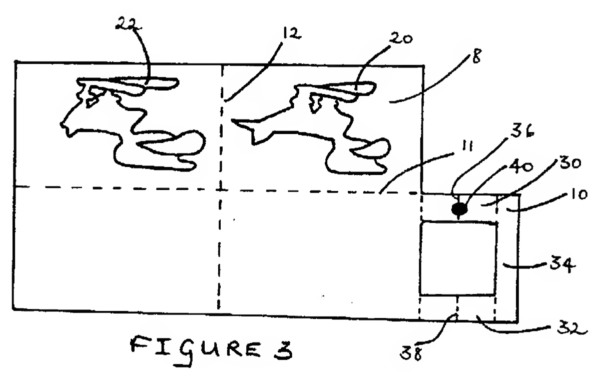

FIGURE 3

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

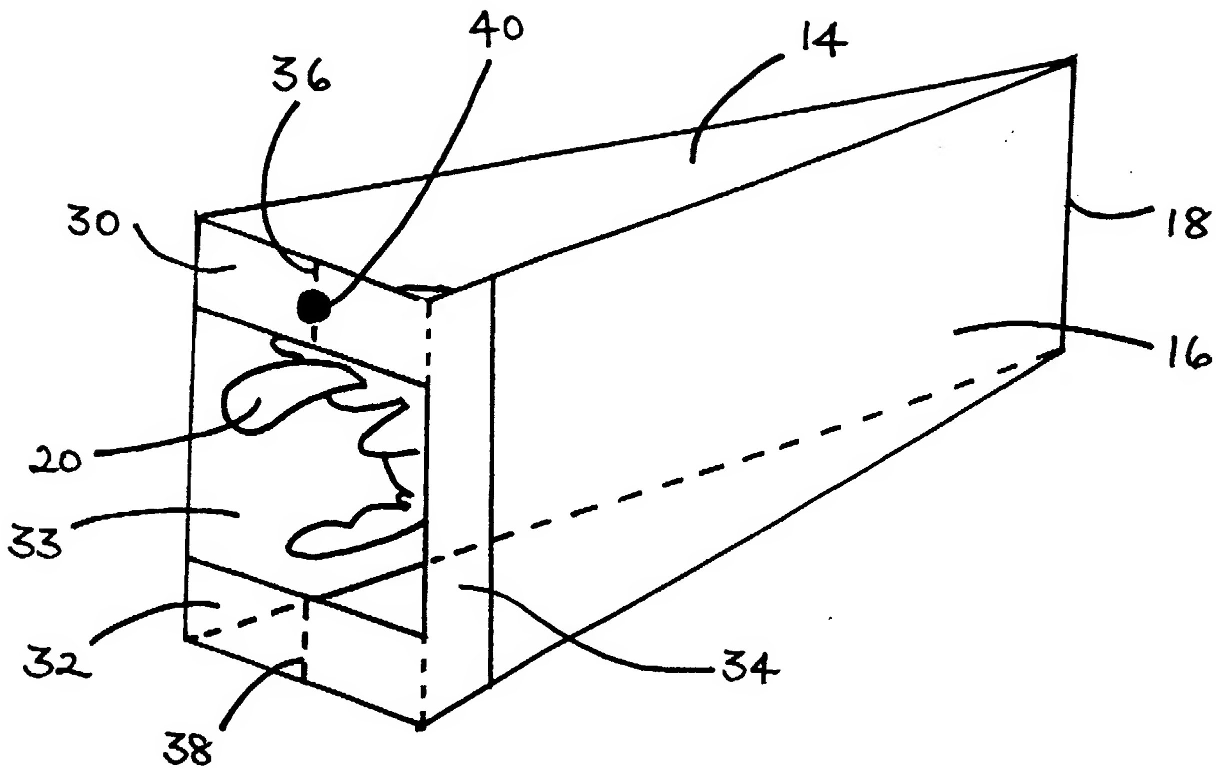

FIGURE 1

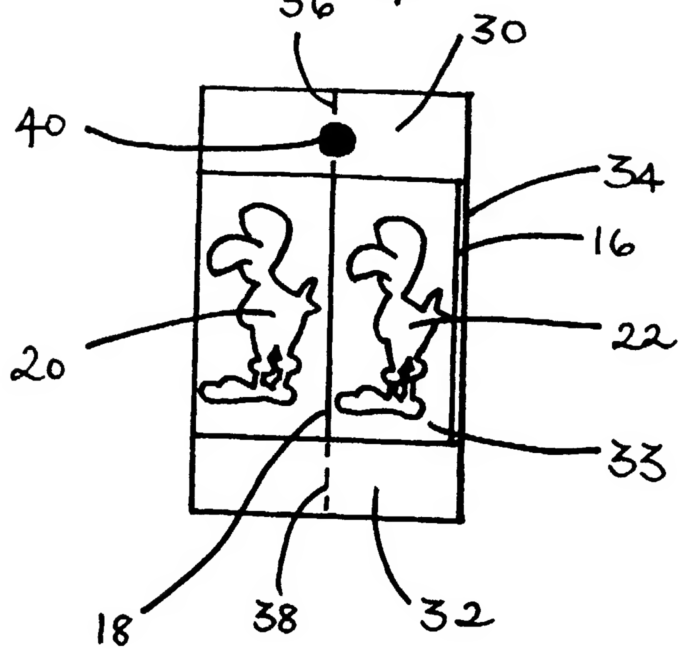

FIGURE 2

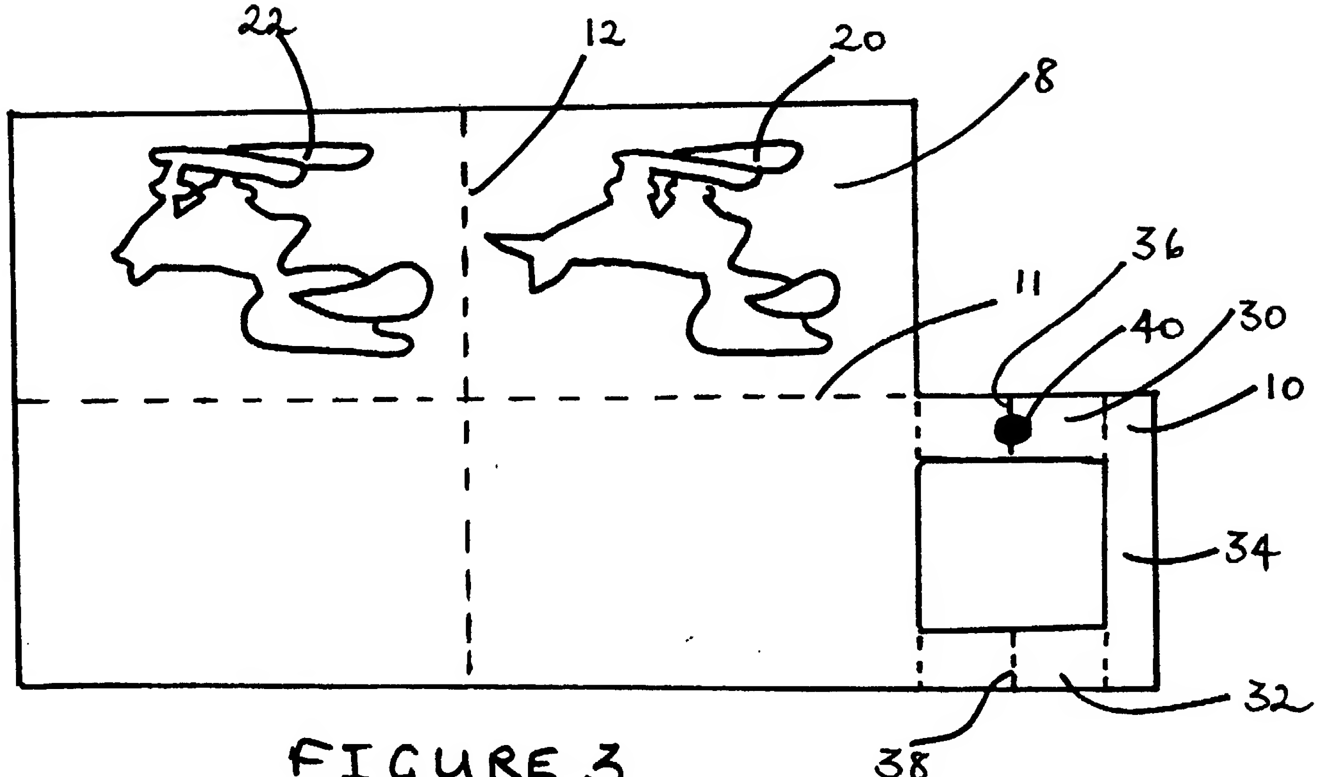

FIGURE 3

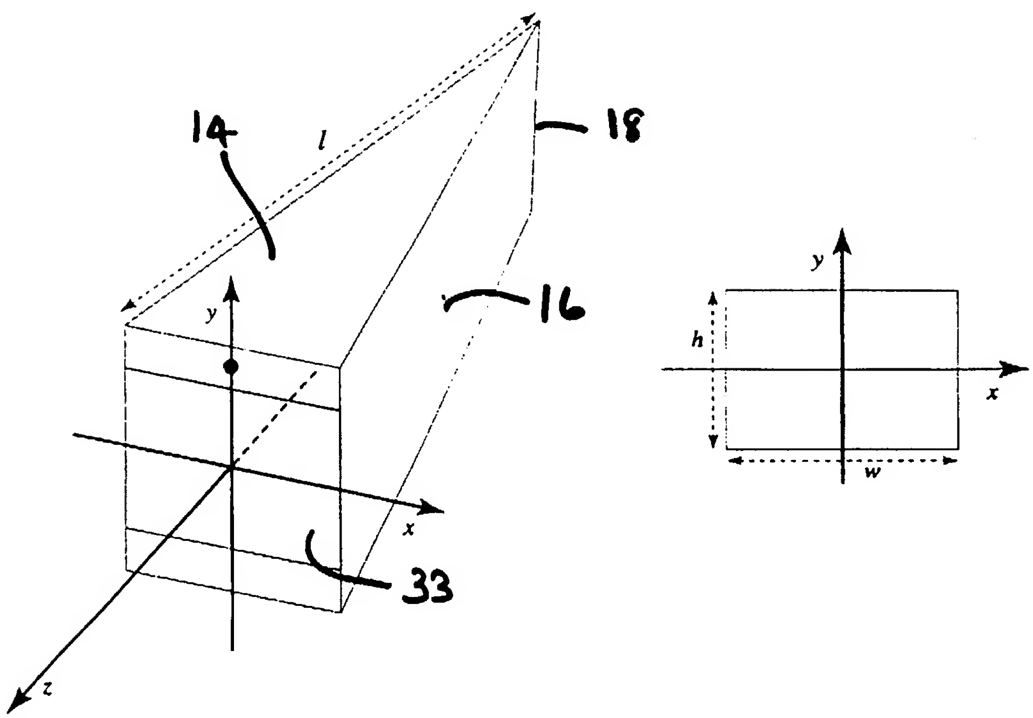

FIGURE 4

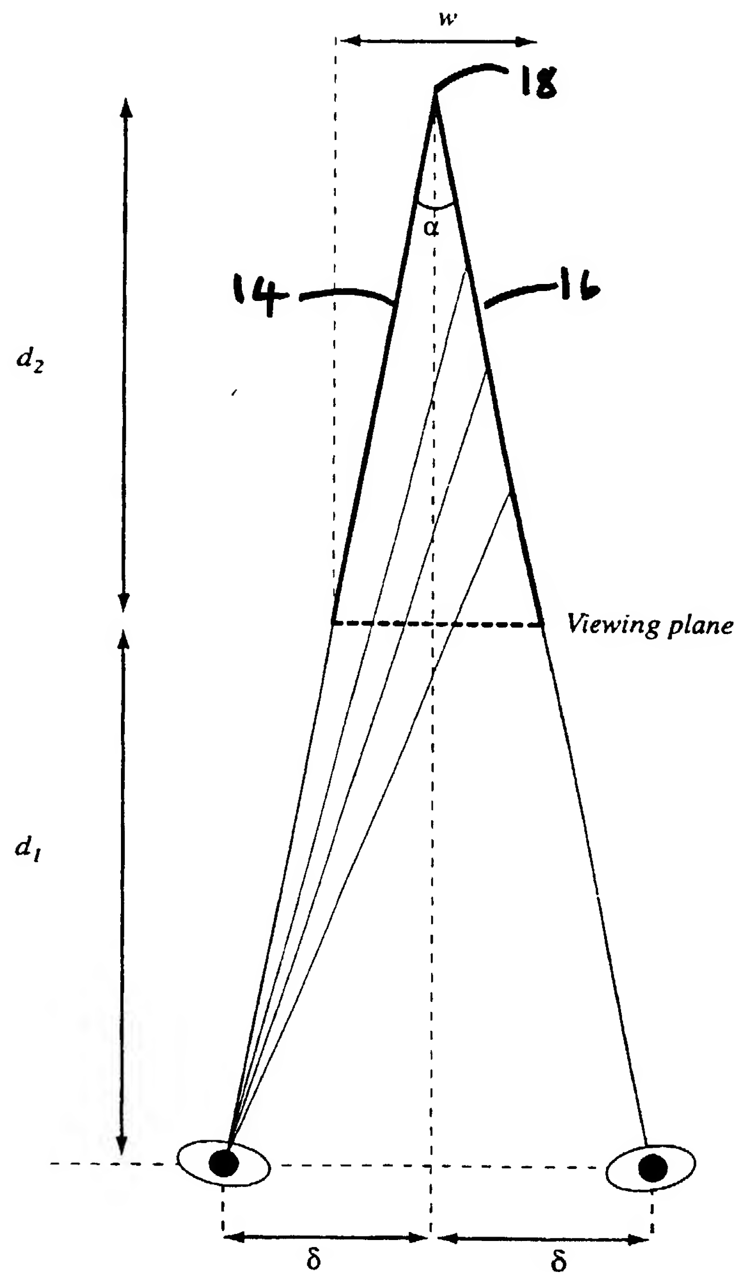

FIGURE 5

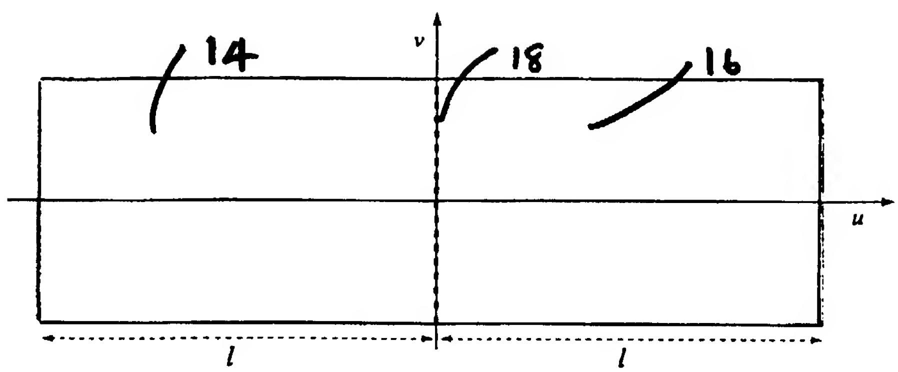

FIGURE 6

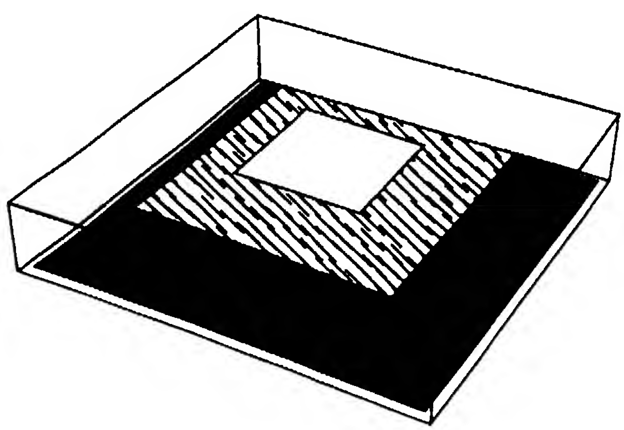

FIGURE 7

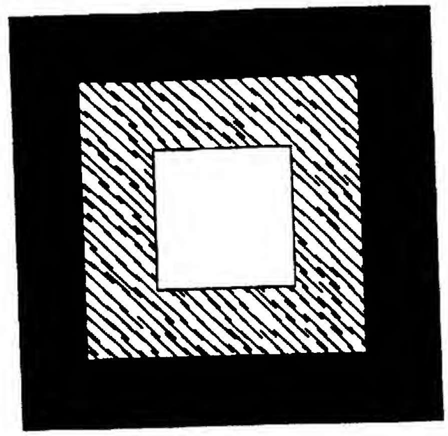

FIG. 8

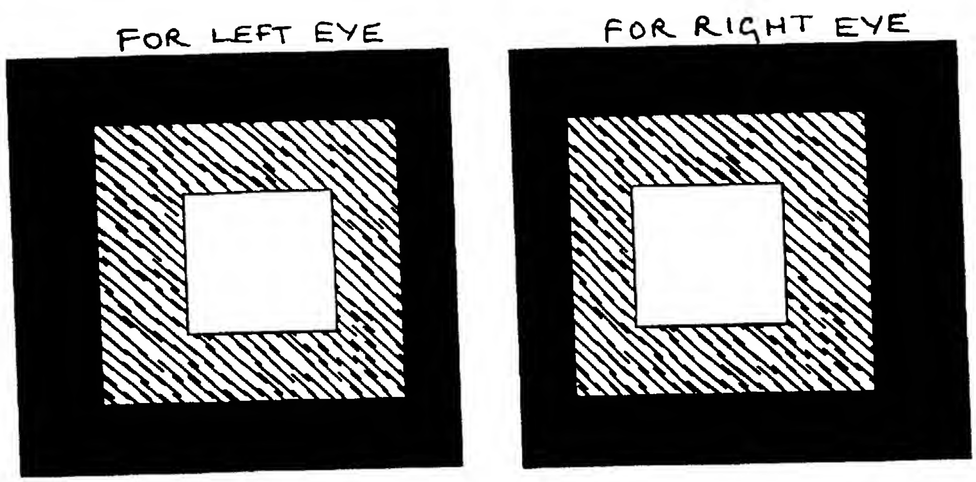

FIG. 9

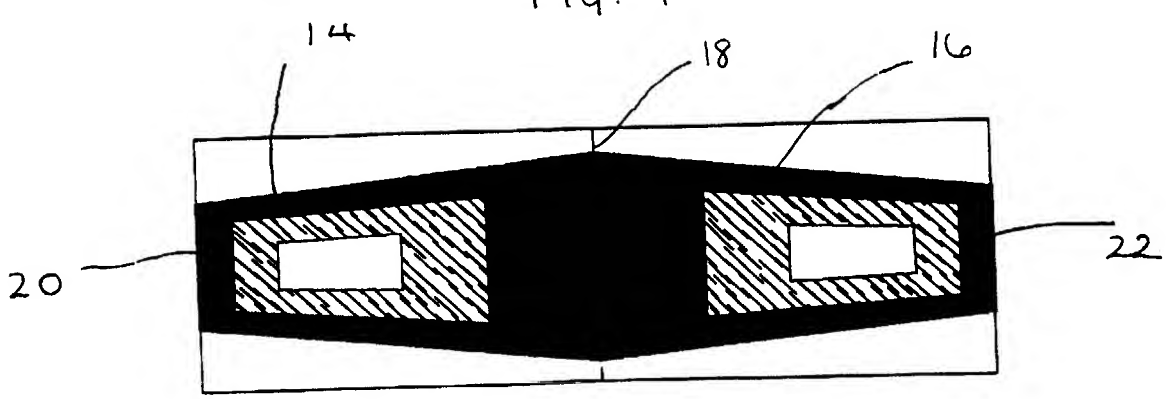

FIG. 10

DISPLAY DEVICE

The present invention relates to display devices and specifically to a display device comprising two surfaces facing one another and diverging from one another, wherein optically distorted images are displayed on the said surfaces, such that, when the line or projected line of convergence of the surfaces is substantially perpendicular to a viewing plane containing a user's eyes, the user sees the illusion of a single image on looking between the two surfaces in a direction such that they converge away from the user's eyes. A display device of the present invention might be used for promotional or advertising material such as business cards, or for entertainment such as in a novelty display device, or for educational or other purposes.

Devices creating the illusion of three-dimensional images work by supplying a slightly different two-dimensional image to each eye. The images are so chosen that, when viewed from a particular position, they represent the separate two-dimensional views which each eye would have of a corresponding three-dimensional object. The brain thus interprets the combined two-dimensional images as a three-dimensional image. An example of a three-dimensional viewing device is the stereoscope, popular during the 19th Century and in current production as the VIEWMASTER RTM. In these devices, a viewer is held to the eyes such that each eye can see only one of a pair of slightly different images through the correct eye-piece. This has the disadvantage that a separate apparatus from the printed cards is required to see the three-dimensional image. Stereoscopes are often bulky,

although folding models have been disclosed, e.g. in US-A-5309281.

The direction of different images to each eye is achieved differently in 3D cinemas by the use of special glasses. The lenses of the glasses may be perpendicularly polarised, with the two slightly different projected sets of two-dimensional images also perpendicularly polarised, such that only one set of images is visible to each eye. Alternatively, the lenses of the glasses may be of different colours (anaglyphic glasses), with one of the two slightly different projected sets of two-dimensional images in each colour, such that each lens filters out the images in its own colour, and only one set of images (that of the colour differing from the lens colour) is visible to each eye. The disadvantage of these systems is the need to wear special glasses to see the three-dimensional effect, and using the anaglyphic system there is the additional disadvantage of limitations on the 3D film colours.

US-A-4259808 discloses a kaleidoscope apparatus in the form of two rectangular mirrors joined at one edge and diverging, with the space between the surfaces enclosed by a transparent cover. Ferrous metal pieces within the kaleidoscope may be moved by means of a magnet such that, on looking through the transparent cover when the kaleidoscope is standing on one of its triangular faces, the ferrous pieces at different heights appear to form a three-dimensional cylindrical pattern. However, this apparatus is not stereoscopic.

US-A-6046850 discloses a stereoscope apparatus where the paths of the user's eyes are separated without the need for

eyepieces. The apparatus comprises left and right reflective sheets, converging towards the line of sight of the user in upright position at an angle of 40 to 50°, such that the left eye sees only the left reflective sheet and the right eye sees only the right reflective sheet. A slightly different picture or image is held at 40 to 50° to each reflective sheet such that the pictures or images are reflected by the reflective sheets to the left and right eyes of the user separately. This apparatus is simple in construction, has no colour limitations, may be used for still or moving pictures and may be made in various sizes. However, the reflective sheets and picture holding means are enclosed in a box-like structure so that a somewhat bulky apparatus is still required to view the three-dimensional effect.

The present invention provides a display device comprising two surfaces facing one another and diverging from one another, wherein optically distorted images are displayed on the surfaces, such that, when the line or projected line of convergence of the surfaces is substantially perpendicular to a viewing plane containing a user's eyes, the user sees the illusion of a single image on looking between the two surfaces in a direction such that they converge away from the user's eyes.

Preferably, the single image is a three-dimensional image.

Preferably the surfaces are the surfaces of sheet members.

Preferably the display device is capable of being folded flat.

Preferably the surfaces are joined along a shared edge, constituting the line of convergence. The edge may further constitute a fold to allow the display device to be folded flat. The surfaces may also be joined in other ways e.g. by a third surface sharing an edge with each surface on the convergent side of the surfaces from the optically distorted images, such that there is a projected line of convergence of the two surfaces but no actual line of convergence. The shared edges may constitute folds to allow the display device to be folded flat.

Preferably the surfaces are planar and more preferably the two surfaces are of the same size and shape. The surfaces may be rectangular, and may be similar in size to a business card (approximately 9 cm by 6 cm).

Preferably the surfaces are prevented from exceeding a preferred angle to one another by one or more restraints. The restraints may comprise a top and bottom restraint and the restraints are preferably attached at the divergent edges of the surfaces (i.e. across the front face). The restraint or restraints may be capable of folding or collapsing to allow the device to be folded flat or may be rigid. Alternatively, the space between the surfaces could be completely or substantially enclosed by a restraint in the form of a cover, including a transparent viewing window in the front face. Suitable materials for such a window might include transparent plastics or glass.

Preferably, a prominent mark is displayed on the restraint or restraints to aid in viewing the illusion of the image. The prominent mark may, for example, be printed on the restraint or restraints.

Preferably the angle of divergence of the surfaces is between 10 and 30°, and more preferably the angle of divergence of the surfaces is about 18°.

Suitable materials for constructing a display device of the present invention may include card or other materials e.g. plastics.

The said optically distorted displayed images of the present invention may be printed static images or may be moving images. The moving images may be displayed on liquid crystal displays forming the surfaces (for example, the images may be used in a game), or the moving images may be back-projected onto screens forming the surfaces.

The present invention may be a large, for example cinema-sized, embodiment, wherein the surfaces are viewed by many users, each with a blinkering device that only allows the presentation of one image to each of the user's eyes.

In a second embodiment, the invention relates to a display device comprising two parallel or substantially parallel surfaces facing away from one another, wherein optically distorted images are displayed on the surfaces, such that, when the surfaces are held between the eyes and substantially perpendicular to a line containing the user's eyes, the user sees the illusion of a single image on looking at the two surfaces. This aspect of the invention may be used in combination with features of the first aspect of the invention.

Figure 1 is a perspective view of a display device of the present invention.

Figure 2 is a diagram of the display device of Figure 1 from the front.

Figure 3 is a plan view of the piece of card used to construct the display device of Figure 1.

Figure 4 shows (left) the global coordinate system used to describe the viewing setup and (right) the viewing region.

Figure 5 is a plan view of the display device of Figure 1 and a viewer's eyes. The viewing region lies in the plane z = 0, which is labelled as the "viewing plane".

Figure 6 shows the coordinate system used on the inside panels of the device.

Figure 7 shows a perspective view of three squares floating one above another.

Figure 8 shows a plan view of the squares of Figure 7.

Figure 9 shows a stereo pair derived from Figure 8.

Figure 10 shows the inside surfaces of a device of Figure 1 designed to present the stereo pair of Figure 9.

The illustrated display device of the invention comprises a piece of card 8 (Figure 3) in the shape of a rectangle with a U-shaped projection 10 extending from half the width of one end. The piece of card 8 is folded in half lengthwise along a fold 11 and the two halves glued together. The piece of card 8 is then further folded in half widthwise along a fold 12 to form two planar rectangular surfaces 14 and 16 (Figure 1) diverging from a shared edge 18 at an angle of 18° with a U-shaped projection 10 extending from the end of surface 14. On the inner face of rectangular surface 14 is printed an optically distorted image 20 (see below) and on the inner face of rectangular surface 16 is printed an

optically distorted image 22. The U-shaped projection 10 comprises strips 30 and 32 which cross the top and bottom of front face 33 (the wide end of the wedge defined by the rectangular surfaces 14 and 16) such that end 34 of the U-shaped projection 11 is glued to the outer face of the rectangular surface 16. The strips 30 and 32 thus act as restraints to hold the rectangular surfaces 14 and 16 at the required divergence angle to allow viewing of the three-dimensional image. With the edges of the surfaces 14 and 16, the strips 30 and 32 form a viewing window at one end of the device. Strips 30 and 32 have central folds 36 and 38 such that strips 30 and 32 may be folded inwards to allow the rectangular surfaces 14 and 16 to be brought together to close the display device flat for convenient storage or transportation. A red dot 40 is printed in the centre of the upper strip 30. The distorted images 20 and 22 are generated from a stereo pair of undistorted images such that the distorted images 20 and 22 appear undistorted when viewed from front face 33. A background may be added which is identical on the inner faces of the rectangular surfaces 14 and 16 and hence will appear as a two-dimensional background behind the three-dimensional image when the three-dimensional image is viewed.

To view the three-dimensional image, the display device should be opened with strips 30 and 32 fully straightened and orientated with the front face 33 forward and the strips 30 and 32 at top and bottom respectively. The display device should be held *ca.* 30 cm from the user's eyes and the user should focus on the red dot 40. When the display device is moved slowly towards the user's eyes with the user continuing

to focus on the red dot 40, the user's eyes cross such that the user's right eye sees the distorted image 20 on the inner face of the left-hand surface 14 and the user's left eye sees the distorted image 22 on the inner face of the right-hand surface 16. The combination of these two distorted images results in the illusion of an undistorted three-dimensional image between the surfaces 14 and 16.

In contrast with the prior art, this preferred embodiment of the present invention provides a three-dimensional display device which is simple in construction, without the need for reflective surfaces or lenses, since once the distorted images are printed on the surfaces the three-dimensional effect depends only on positioning the surfaces at the correct divergence angle, rather than on external apparatus to separate the paths of the user's eyes. The display device may be made very small in size e.g. 9 cm x 6cm x 2mm when folded, approximately the size of a business card. Both of these differences constitute advantages over the stereoscopic apparatus described in US-A-4259808, which also uses angles surfaces to separate the paths of the user's eyes, but requires reflective surfaces and box-like holding means, because distorted images are not used.

Optically distorted images 20, 22 for use with the invention may be produced from a stereo pair of images using the following mapping formulae (whose derivation is explained in the Appendix).

Points on the inner face of the right-hand surface 16 (seen by the viewer's left eye):

$$u_L(x,y) = \frac{\delta(x\cot(\alpha/2) + d_2)}{(x + 2\delta)\cos(\alpha/2) - d_2\sin(\alpha/2)}$$

$$v_L(x,y) = \frac{2y\delta\cos(\alpha/2)}{(x + 2\delta)\cos(\alpha/2) - d_2\sin(\alpha/2)}$$

where: u and v are the horizontal and vertical coordinates respectively of a point on the inner faces of the surfaces 14, 16 of the device relative to the centre of the shared edge 18 (Figure 6);

x and y are the horizontal and vertical coordinates respectively of the corresponding point in the front face 33 of the device relative to the centre of the front face 33 (Figure 4);

δ is half the separation of the user's eyes (Figure 5), for example 3.5 to 4 cm;

α is the angle between the surfaces 14 and 16 (Figure 5); and

d_2 is the distance from the front face 33 to the shared edge 18 (Figure 5).

Points on the inner face of the left-hand surface 14 (seen by the user's right eye):

$$u_R\ (x,y) = \frac{\delta(d_2 - x\cot(\alpha/2))}{(x - 2\delta)\cos(\alpha/2) + d_2\sin(\alpha/2)}$$

$$v_L\ (x,y) = \frac{2y\delta\cos(\alpha/2)}{(x - 2\delta)\cos(\alpha/2) + d_2\sin(\alpha/2)}$$

where u, r, x, y, δ, α and d_2 are as defined above.

Whilst the invention has been described with reference to the illustrated preferred embodiment, it is to be appreciated that many modifications and variations are possible within the scope of the invention.

For example, the two undistorted images used to generate the distorted images 20, 22 might not be a stereoscopic pair, so that the image seen by the viewer would not be three dimensional.

As a further alternative, suitably distorted images 20, 22 might be printed on the inside of a cylinder or a cube, or printed on both surfaces of a single sheet (which would be held by the viewer between the eyes and perpendicular to a line containing the eyes for viewing).

Appendix

Section 1 - Introduction

This Appendix explains how to prepare the images 20, 22 that are printed on the inner faces of the surfaces 14, 16 of the device from a stereo pair: that is, a pair of images, one for each eye, that when displayed so that each eye perceives only its own image, create the illusion of depth. An example of such a pair appears in Section 4 below.

The next section defines coordinate systems to describe the viewing setup and positions in the various images. Section 3 gives the formulae, Equations 1 and 2, that transform the members of the stereo pair into the images 20, 22 to be printed on the device itself. Section 4 works through a simple example and Section 5 gives details of the calculations leading to the formulae of Section 3.

Section 2 - Notation

Figure 4 shows a cartoon sketch of a device of the invention. The front face 33 is the end through which a user looks into the device and is referred to as the viewing region. It is necessary to print distorted images 20, 22 on the inner faces of the surfaces 14, 16 of the device to give the same impression as an undistorted image printed on the viewing region.

Figure 4 also illustrates one of the two coordinate systems needed in order to set up the problem. This system, referred to as the global coordinate system, has its origin in the center of the viewing region. The x-axis is horizontal

and x increases to the right while the y-axis is vertical and y increases upward. The z-axis points out of the centre of the device toward the user so that the user's eyes are at positions with $z > 0$ and the bulk of the device has $z < 0$. The viewing region itself lies in the plane $z = 0$ and so positions on it are specified by their x and y coordinates alone: the inset at the right of Figure 4 emphasizes this. The Figure also illustrates the definitions of three important quantities: l, the length of the side-panels of the device; h, the height of the viewing region and w, its width.

Figure 5 shows the viewing setup as a whole, including the user's eyes, which are treated as points (of course real eyes are not single points, but they are optical systems with focal points which, for the purposes of this construction, amount to the same thing) at the positions $(-\delta, 0, d_1)$ (left eye) and $(\delta, 0, d_1)$ (right eye). The distance between the eyes is thus 2δ. When the device is properly oriented and held at the correct viewing distance lines of sight (rays) issuing from the left eye pass through the viewing region and graze the left hand surface 14 of the device, but strike the right hand surface 16, as shown. The figure also illustrates three useful quantities: α, the angle between the side-panels of the device, d_1, the distance at which the device should be held and d_2, the distance from the centre of the viewing region to the middle of the shared edge 18 at the back of the device.

Figure 6 illustrates the two-dimensional coordinate system used to describe positions on the inner faces of the surfaces 14, 16 of the device. If the device is cut open and spread flat, the origin of the panel coordinate system is in

the centre of the shared edge 18 at the back of the device. Points on the inner face of the left hand surface 14 of the device (that is, those that will be viewed with the right eye) have $u < 0$ while those on the right hand surface 16 (to be viewed by the left eye) have $u > 0$. In the next section formulae are provided which can be used to map points in the viewing region (with global coordinates $(x, y, 0)$) onto points on the surfaces 14, 16 of the device (with coordinates (u, v)).

Section 3 - Mapping the Images

To begin with, it is helpful to summarize all the various dimensions and symbols that appeared in the figures of the previous section.

Table 1: Parameters describing the device and the viewing setup.

Symbol	Description	Illustrated in
w	Width of viewing region	Figs. 4 and 5
h	Height of viewing region	Fig. 4
l	Length of long edge of device	Figs. 4 and 6
α	Angle between panels	Fig. 5
d_1	Distance from	Fig. 5

	device to eyes	
d_2	Distance from viewing region to crease	Fig. 5
δ	Half the separation of the eyes	Fig. 5

The lengths w, h and l are dimensions of the device itself and the angle α may be computed from them. Relations between these quantities and the remaining parameters are summarized in Table 2.

Table 2: Relations among the parameters: everything is given in terms of the dimensions h, w and l of the device and the spacing 2δ between the subject's eyes.

Symbol	Formula
h	May be measured from device
w	May be measured from device
l	May be measured from device
δ	Must be estimated: typical values are 3.5 - 4 cm.
α	$\alpha = 2 \arcsin(w/(2l))$
d_2	$d_2 = \sqrt{(l^2 - (w/2)^2)}$
d_1	$d_1 = ((2\delta/w) - 1)d_2$ $= ((2\delta/w) - 1)\sqrt{(l^2 - (w/2)^2)}$

The image on the right hand surface 16

The image 22 intended for the left eye is printed on the inner face of the right hand surface 16 of the device. To work out how to print this image:

1. Scale the image so it is the same size as the viewing region: h by w.

2. Install an (x, y) coordinate system whose origin is in the centre of the image; the lower left corner will thus have coordinates (-w/2, -h/2) while the upper right corner has (w/2, h/2).

3. Map each point (x, y) in the image to a point on the right hand surface of the device using the relations:

$$u_L(x, y) = \frac{\delta\ (x \cot(\alpha/2) + d_2)}{(x + 2\delta)\cos(\alpha/2) - d_2 \sin(\alpha/2)}$$

$$v_L(x, y) = \frac{2y\delta \cos(\alpha/2)}{(x + 2\delta)\cos(\alpha/2) - d_2 \sin(\alpha/2)} \qquad (1)$$

This mapping gives positions in the (u, v) coordinate system illustrated in Figure 6. One can prove that if (x, y) lies in the viewing region, $-w/2 \le x \le w/2$ and $-h/2 \le y \le h/2$, then the corresponding point will lie to the right of the shared edge 18. That is, it will have $u_L(x, y) \ge 0$.

The image on the left hand surface 14

The procedure for the image 20 to be viewed by the right eye (and so printed on the left hand surface 14) is similar, but rather than using the mapping (1) in Step 3, one uses the relations:

$$u_R(x, y) = \frac{\delta (d_2 - x \cot (\alpha /2))}{(x - 2 \delta) \cos (\alpha/2) + d_2 \sin(\alpha/2)}$$

$$v_R(x, y) = \frac{2y\delta \cos (\alpha /2)}{(x - 2 \delta) \cos (\alpha/2) + d_2 \sin(\alpha/2)} \qquad (2)$$

One can show that this mapping sends points in the viewing region to the left of the shared edge 18. That is, $u_R(x, y) \leq 0$.

The device has a right-left symmetry that implies relations between the mappings described above. These might prove helpful in computer implementations:

$$u_R(x, y) = -u_L(-x, y)$$

The next section illustrates these mappings with a simple example.

Section 4 - Example

Figure 7 shows a simple 3D image in which a small square floats above a larger square which, in turn, floats above a ground. Figure 8 shows a view from above while Figure 9 shows an associated stereo pair. If the dimensions listed in Table 3 below are used (recall that the separation between the eyes is 2δ, so the value $\delta = 3.75$ listed in Table 3 corresponds to a distance of 7.5 cm. between the eyes) the resulting inner faces of the surfaces 14, 16 are as pictured in Figure 10.

The mappings onto the surfaces 14, 16 do not preserve shapes. Square regions in the images making up the stereo pair are distorted by the mapping, becoming trapezoidal regions on the surfaces 14, 16. Although this example involves large squares, similar distortions will occur for smaller squares as well. In particular, the mappings (1) and (2) do not preserve the shapes of pixels: single pixels in the original images may be spread over several pixel-sized areas on the side panel.

Table 3: Dimensions used to produce the panels pictured in Figure 7 from the stereo pair in Figure 6. The values of h, w and l are approximately the same as those for the device of Figure 1.

Basic dimensions	Derived quantities
h 3.0 cm	$\alpha \approx 19.2°$
w 3.0 cm	$d_1 \approx 13.3$ cm
l 9.0 cm	$d_2 \approx 8.9$ cm
δ 3.75 cm	

Section 5 - Calculation

This section gives a brief review of the calculations leading up to the formulae in Section 3. We begin by considering a ray that starts from the left eye (which has position $(-\delta, 0, d_1)$ in the global coordinate system of Figure 4 and passes through a point $(x^*, y^*, 0)$ in the viewing region. Such a ray may be parameterized as:

$$\gamma_L(t) = (1 - t)(-\delta, 0, d_1) + t(x^*, y^*, 0) \qquad (3)$$

where $t \geq 0$ and, when $t = 0$,

$$\gamma_L(0) = (-\delta, 0, d_1),$$

the position of the left eye. When $t = 1$ we have

$$\gamma_L(1) = (x^*, y^*, 0)$$

the point in the viewing region. The point where this ray intersects the right hand surface 16 of the device is required.

This right hand surface 16 is contained in a plane that contains both the shared edge 18 at the back of the device and the point that lies in the middle of the right edge of the viewing region. The shared edge 18 is part of a line which, in the global coordinate system,
is the set

$$\{(x, y, z) \mid x = 0, y \in \Re \text{ and } z = -d_2\}$$

while the midpoint of the right edge of the viewing region has coordinates (w/2, 0, 0). Geometric considerations based on Figures 4 and 5 tell us that the normal vector to the plane containing the right panel of the device is thus

$$\hat{n}_R = (-\cos\ (\alpha/2),\ 0,\ \sin(\alpha/2))$$

and so the plane itself is the set of points (x, y, z) satisfying:

$$(x,\ y,\ z) - (0,\ 0,\ -d_2) \cdot \hat{n}_R = 0 \qquad (4)$$

where the · indicates the usual scalar- or dot-product of two vectors.

Substituting the components of $\gamma_L(t) = (x(t),\ y(t),\ z(t))$ into (4) and solving for t, we find that the ray (3) strikes the right hand surface 16 of the device when

$$t = t_L(x^*,\ y^*) = \frac{2\delta\ \cos(\ \alpha/2)}{(x^* + 2\delta)\ \cos(\ \alpha/2)\ -\ d_2\ \sin\ (\alpha/2)}$$

All that remains is to convert the global coordinates of the point of intersection, $\gamma_L\ (t_L\ (x^*,\ y^*))$, into local coordinates on the side-panel (the (u, v) system illustrated in Figure 6). This is accomplished with the formulae:

$$u_L(\ x^*,\ y^*) = (\gamma_L(t_L(x^*,y^*))-(0,0,-d_2))\cdot(\sin(\alpha/2),0,\cos(\alpha/\ 2))$$

$$v_L(x^*, y^*) = (\gamma_L(t_L(x^*,y^*)) - (0,0,-d_2)) \cdot (0,1,0)$$

which lead to Equation(1) in Section (3).

The calculations for the right eye (producing the image on the inner face of the left hand surface 14) are essentially identical, save that the intermediate results have different names and slightly different forms:

$$\gamma_R(t) = (1 - t)(\delta, 0, d_1) + t(x^*, y^*, 0)$$

$$n_R = (\cos(\alpha/2), 0, \sin(\alpha/2))$$

$$t_R(x^*, y^*) = \frac{2\delta \cos(\alpha/2)}{(2\delta - x^*)\cos(\alpha/2) + d_2 \sin(\alpha/2)}$$

$$u_R(x^*, y^*) = (\gamma_R(t_R(x^*,y^*)) - (0,0,-d_2)) \cdot (\sin(\alpha/2), 0, -\cos(\alpha/2))$$

$$v_R(x^*, y^*) = (\gamma_R(t_R(x^*,y^*)) - (0, 0,-d_2)) \cdot (0,1,0)$$

What is claimed:

1. A display device comprising two surfaces facing one another and diverging from one another, wherein optically distorted images are displayed on the surfaces, such that, when the line or projected line of convergence of the surfaces is substantially perpendicular to a viewing plane containing the user's eyes, the user sees the illusion of a single image on looking between the two surfaces in a direction such that they converge away from the user's eyes.

2. A device as claimed in Claim 1, wherein the single image is a three-dimensional image.

3. A display device as claimed in Claim 1 or Claim 2, wherein the surfaces are the surfaces of sheet members.

4. A display device as claimed in any one of the preceding claims, wherein the display device is capable of being folded flat.

5. A display device as claimed in any one of the preceding claims, wherein the surfaces are joined along a shared edge, constituting said line of convergence.

6. A display device as claimed in any one of the preceding claims, wherein the surfaces are planar.

7. A display device as claimed in any one of the preceding claims, wherein the two surfaces are of the same size and shape.

8. A display device as claimed in any one of the preceding claims, wherein the said surfaces are rectangular.

9. A display device as claimed in Claim 8, wherein the dimensions of the rectangular surfaces are approximately 9 cm by 6 cm.

10. A display device as claimed in any one of the preceding claims, wherein the surfaces are prevented from exceeding a preferred angle to one another by one or more restraints.

11. A display device as claimed in Claim 10, wherein the restraint or restraints are attached at the divergent edges of the surfaces.

12. A display device as claimed in Claim 10 or Claim 11, wherein the restraint or restraints are capable of folding or collapsing to allow the device to be folded flat.

13. A display device as claimed in Claim 10, Claim 11 or Claim 12, wherein a prominent mark is displayed on the said restraint or restraints to aid in viewing the illusion of the single image.

14. A display device as claimed in Claim 13, wherein the prominent mark is printed on the restraint or restraints.

15. A display device as claimed in any one of the preceding claims, wherein the divergence angle of the surfaces is between 10 and 30°.

16. A display device as claimed in Claim 15, wherein the divergence angle of the surfaces is 18°.

17. A display device as claimed in any one of the preceding claims, wherein the device is constructed from card.

18. A display device as claimed in any one of the preceding claims, wherein the optically distorted images are images printed on the surfaces.

19. A display device as claimed in any one of Claims 1 to 16, wherein the said surfaces are liquid crystal displays.

20. A display device as claimed in any one of Claims 1 to 8 or Claims 10 to 16, wherein the said surfaces are screens and the distorted images are achieved by back-projection of images onto the said screens.

21. A display device as claimed in Claim 19 or Claim 20, wherein the optically distorted images are moving images.

22. A display device as claimed in Claim 21, wherein the device is cinema-sized, and is viewed using a blinkering device which only allows the presentation of one of the distorted images to each of a user's eyes.

23. A display device comprising two parallel or substantially parallel surfaces facing away from one another, wherein optically distorted images are displayed on the surfaces, such that, when the surfaces are held between the eyes and substantially perpendicular to a line containing the user's eyes, the user sees the illusion of a single image on looking at the two surfaces.

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Application No: GB 0216406.9
Claims searched: 1 - 23

Examiner: Andrew P Jenner
Date of search: 8 October 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A		GB 2332532 A BRS VISION LTD.
A		FR 2830342 A FUNTEN - see figures 12 - 17

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

G2J
H4F

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

G02B
H04N

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO